1962

A study of nematode parasites of some California salamanders

Herbert Bruce Johnston
University of the Pacific

A STUDY OF NEMATODE PARASITES OF
SOME CALIFORNIA SALAMANDERS

A Thesis
Presented to
the Faculty of the Department of Biological Sciences
University of the Pacific

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts

---

by
Herbert Bruce Johnston
July 1962

This thesis is approved for recommendation to the Graduate Council.

Department Chairman or Dean:

Ernest P. Edwards

Thesis Committee:

Donald J. [illegible], Chairman

Ernest P. Edwards

John S. Tucker

Dated July 10, 1962

ACKNOWLEDGMENTS

I am deeply indebted to Dr. Donald L. Lehmann of the University of the Pacific under whose guidance this study was made. His many helpful suggestions were of great value to me. I should also like to express appreciation to Dr. Nathan W. Cohen of Modesto Junior College for his contribution of specimens and his verification of identifications of salamanders.

TABLE OF CONTENTS

INTRODUCTION

Little information is available concerning the nematode parasites of salamanders in California. Lehmann (1954) reported the finding of _Oxyuris dubia_ Leidy 1856, in the rectum of 33 _Ensatina e. eschscholtzii_ from Sonoma County, California, and in 3 of 10 _Batrachoseps a. attenustus_, from San Francisco County, California. He also reported _Oxyuris magnivulvaris_ Rankin 1937 in the rectum of 1 of 2 _Aneides flavipunctatus_, from Marin County, California and _Rhabdias_ sp., from lungs of 2 of 12 aquatic _Triturus torosus_ from Contra Costa County, California. Lehmann (1960) reported _O. dubia_ from the cloaca of 1 _Aneides flavipunctatus_ and 3 _Aneides lugubris_ taken in Marin and Sonoma Counties, California. Several similar studies have been made in other states citing the occurrence of nematodes in various species of salamanders, e.g., Oregon, Lehmann (1954) and (1956), Massachusets, Wolton (1935), and North Carolina, Rankin 1937).

There is an even greater paucity of information concerning parasitism in those salamander species inhabiting the western slope of the Sierra Nevada. This investigation is concerned with the four most common salamanders of the central California slopes, _Aneides lugubris_ Hallowell, _Batrachoseps attenuatus attenuatus_ Eschscholtz, _Ensatina eschscholtzii platensis_ Espada, and _Taricha torosa sierrae_

Twitty.

Individuals of these species were collected and examined for parasites over the fall, winter and spring months, commencing in the fall of 1960 and extending through the spring of 1962. Data were collected to determine what nematode species inhabit these hosts and to ascertain the incidence and sites of infection. An attempt was also made to determine whether time of year, environmental conditions, and geographic distribution are of particular significance in the host-parasite relationships studied. A second group of salamanders which included *Aneides lugubris* Hallowell and *Taricha torosa* Rathke was examined. Both of these species were taken in a coastal region and were used as a comparison group.

Special attention has been directed to the study of *Oxyuris dubia* Leidy, 1856, with the intent of clarifying Leidy's description of this species. This nematode is a frequent parasite of the salamanders studied, and special consideration has been given to the culturing of their eggs in an attempt to better understand the pattern of development.

MATERIALS AND METHODS

Hosts were collected mainly by rolling over logs, lifting boards, rocks, and examining leaf litter and rotten logs. All of the terrestrial species were sufficiently sluggish in their movements to allow hand capture. Some salamandrids were taken from streams with a dip net. Most specimens were placed in half gallon or gallon bottles with wet paper toweling where they remained in good condition for several days. Most of the animals were placed in the refrigerator at 8°C and kept there until they were killed and autopsies were made. Specimens of *Taricha torosa* were placed in gallon bottles about one third filled with stream water. Members of this species also survived well when placed in the refrigerator at 8°C.

Autopsies were carried out by opening the body cavity, removing segments of the digestive system, and placing the portions in Syracuse watch glasses filled with 0.7% saline solution. Preliminary examination was made with a 10 power stereo-microscope, after first checking the body cavity and anal region for parasites. The digestive system and its appendages were divided into four segments: (a) esophagus and stomach, (b) small intestine, (c) large intestine and rectum, (d) liver and gall bladder. The individual segments were opened or teased apart for preliminary examination under the stereo-microscope. Adult worms, larvae, and eggs that were observed were removed for further study. Sample portions of the body wall and digestive organs were examined under the compound microscope to determine if there were cysts or other forms of parasites present in these regions. Other organs, e.g., heart and kidneys, were examined in some individuals, but not in all specimens taken. Lung tissue was examined in those specimens that possessed it.

Killing and Preserving:

Nematodes, their eggs, and larvae were killed in an alcohol-glycerine solution (80 parts alcohol, 10 parts glycerine) heated to a temperature of 47°C. This method was used for killing specimens that were to be prepared as whole-mounts and as study specimens kept in the Syracuse watch glasses. Some specimens of *Oxyuris dubia* were killed in 10% formalin or in Bouin's solution for subsequent sectioning.

Mounting:

Whole mounts were made by mounting specimens from the alcohol-glycerine solution (held at 47°C for twenty-four hours) in glycerine jelly. After covering, the slides were removed to the refrigerator for the purpose of hardening the mounts.

Specimens used for sectioning were removed from the alcohol-glycerine solution and hand sectioned with a sharp razor blade for temporary study mounts.

Culture Techniques:

Eggs of *O. dubia* were cultured using several techniques. Methods one through four below involved the use of sterile solutions contained in petri dishes.

1. Eggs were placed on the inside edge of a doughnut shaped piece of filter paper moistened with 0.7% saline.
2. Eggs were placed on the inside edge of a doughnut shaped piece of filter paper moistened with amphibian Ringer's solution.
3. Eggs were placed on a moist nutrient agar.
4. Eggs were placed on plain agar dissolved in 0.7% saline solution.
5. Eggs were removed with faecal material and placed in a petri dish and kept moist with 0.7% saline solution.
6. Eggs were "cultured" *in vivo* in the female as well as in the host, since the eggs were found to be in various stages of development at the time of autopsy.

Transfers of ova were effected by using either an eye dropper or a single hair mounted in a brush handle. The most effective method, however, was to transfer the female worm to the petri dish and then roll a dissection needle over her body, causing the expulsion of large numbers of eggs. All specimens involved in this study came from the host animals *Aneides lugubris* and *Taricha torosa sierrae*. Eggs that were placed on the white filter paper were difficult to find; therefore a light pencil mark was made beside each cluster of eggs. The eggs could also be pushed with a dissection needle into the center clear spot for close observation. Eggs were kept continuously moist by additions of new sterile medium each day.

Summary of Hosts Examined

1. *Aneides lugubris* Hallowell.	23
2. *Batrachoseps attenuatus attenuatus* Eschscholtz.	5
3. *Ensatina eschscholtzii platensis* Espada.	6
4. *Taricha torosa sierrae* Twitty.	7
5. *Taricha torosa* Rathke.	7
Total Number of Examinations	48

ECOLOGY OF HOSTS EXAMINED

Localities and Habits:

The majority of specimens examined in this study were taken from the western slope of the Central California Sierra Nevada Mountains in Stanislaus and Tuolumne Counties.

The western slope of these mountains is a very gentle one compared to the abrupt eastern slope. The western slope begins on the floor of the San Joaquin Valley which is within a few feet of sea level. The floor of the valley is characterized by the Valley Grassland Community, (Munz and Keck, 1950) and would be classed as Lower Sonoran Life Zone, Merriam (1895). As one progresses up the slope, a series of distinct plant communities can be clearly defined. These communities are now listed in ascending order above the Valley Grassland Community. Because of their wide-spread use in the literature, corresponding Life Zones, according to Merriam, (Ingles 1954), are included in spite of their inferior descriptive value.

Plant Community	Life Zone
1. Valley Grassland	Lower Sonoran
2. Foothill Woodland	Upper Sonoran
3. Yellow Pine Forest	Transition
4. Red Fir Forest	Canadian
5. Lodgepole Forest	Hudsonian
6. Sub Alpine Forest	Alpine Arctic

The areas investigated in this study included all of the above communities with the exception of Lodgepole Pine and Sub Alpine communities. Most host animals were found in Foothill Woodland and Yellow Pine Forest Communities.

A. lugubris was found primarily in the lower Yellow Pine Forest where vegetation is transitional between the

Foothill Woodland and Yellow Pine Forest Communities. All specimens were found under boards, logs, or in a combination of leaf and dirt litter. This species seems to prefer a moist but not overly damp habitat. A number of these organisms were taken in an abandoned lumber yard located near a stream that is dry for a major portion of the year. This area was overgrown with numerous grasses and a few scattered oaks, *Quercus douglasi*; flat boards lying on the ground were numerous. The yard itself extended from the dry stream bed up a gentle slope for about four-hundred yards, terminating next to a stand of *Pinus ponderosa*. This yard was examined thoroughly on three occasions: in May of 1961; November, 1961; and April, 1962. No specimens were found within fifty yards of the stream bed. Most of the specimens taken in this area were found in a belt between fifty and one hundred yards from the stream bed; few occurred beyond this point. This species was by far the most abundant of the four Sierra host species collected.

Specimens of *Batrachoseps attenuatus* were typically found in the Foothill Woodland Community as well as the lower Yellow Pine Forest community. They were found in leaf litter, under boards, and in dead and decaying logs. The few specimens taken were found in damp or moist places. One specimen was taken from the protruding end of a log which was partially submerged in a stream. The inside of the log was extremely wet. The other individuals taken were in more moderately damp situations.

Ensatina eschscholtzii was found in typical Yellow Pine communities where _Pinus ponderosa_ is the dominant plant species and is associated with secondary plant species _Abies concolor_, _Pinus lamertiana_, _Libocedrus decurrens_, and _Quercus niger_. These specimens were characteristically found on open hill-sides and canyons, under logs and boards and in forest litter. Many logs were split apart, but no specimens were found in them. They were always found in damp situations.

Of the four Sierra species collected, _Taricha torosa sierrae_ was found at the lowest elevation. They were netted out of streams of typical lower Foothill Woodland communities. _Quercus douglasi_, _Pinus sabiniana_, _Arctostaphylos_ spp. and numerous grasses are the dominant vegetation of the region. All specimens found were in water, and all were smooth skinned males that had entered the water presumably for the purpose of breeding; the females apparently had not yet arrived, the time being early March Twitty (1955).

The comparison group of salamanders was taken from the Marin County coastal region. It included specimens of the two species _Aneides lugubris_ and _Taricha torosa_. They were collected several miles inland from the coast from an area that might best be described as Upper Sonoran life zone, with predominant vegetation being grasses, scattered oaks and a few conifers. All specimens were taken from under boards and logs in moderately moist situations.

PARASITES OF HOST ORGANISMS

Considering first the salamander hosts taken from the Sierra, it was found that three of the four species observed were parasitized. Aneides lububris was parasitized by Oxyuris dubia. It was determined that 14 of 16 hosts examined were infected with this nematode. In two cases other parasites were found: one host contained two small unidentified nematodes, and another was parasitized with a single unidentified cestode. Ensatina eschscholtzii was parasitized only by O. dubia, and 3 of the 4 adult hosts collected were infected. Six host animals were collected of which two were immature. Of the total number three were parasitized. Taricha torosa sierrae were found to contain O. dubia (6 of the 7 individuals taken were parasitized) and in two cases, other helminth parasites were observed. One host contained individuals of Capillaria sp., a nematode, while another contained an unidentified trematode.

In the A. lugubris of the coastal comparison group, 4 of 7 individuals contained O. dubia and 5 of 7 individuals were parasitized: in one case a host was found to harbor one unidentified trematode. The T. torosa of the coastal comparison group was found to harbor only the trematode Megalodiscus sp. (See tables I through VI for complete data.)

The sites of infection were clearly established for those parasite species studied. O. dubia was found in the large intestine and rectum in every case. They were never found attached to the intestinal wall, but were always free in the faecal material. Capillaria sp. was found in the stomach, small intestine, and body cavity. Megalodiscus sp., the unidentified species of trematode, and the unidentified species of cestode were found attached to the wall of the small intestine.

O. dubia was by far the most common parasite of host species examined in this study. Observation of more than three-hundred individuals revealed the presence of only one male.

REDESCRIPTION OF OXYURIS DUBIA LEIDY 1856

Description of Female Oxyuris dubia

Body cylindrical, fusiform and curved; the tail tapers sharply on dorsal side and is conically acuminate; mouth triangular, unarmed, with three inner lips; cuticle of anterior end strongly annulated, body cuticle annulated but not as strongly as anterior end; esophagus with a prominent posterior bulb, but lacking a prebulbar swelling; anus just anterior to beginning of tail; vulva located just anterior to middle of the body; ovary may or may not be coiled about the esophagus; uterus in gravid females may become greatly distended with eggs appearing to fill most of the body posterior to the esophageal bulb; eggs oval, flattened slightly on one side, operculate and no plug at opposite end; eggs may be observed in various stages of development. (See Plate I)

Measurements:

The following measurements, based on seven adult specimens, are given in mm. unless otherwise stated. Body length 3.54 (2.58-3.80); body width 0.294 (0.22-0.59); length of esophagus 0.66 (0.56-0.66); diameter of esophagus at entrance to esophageal bulb 0.029 (0.029-0.029); anal tail 0.56 (0.41-0.96); vulval tail 1.84 (1.44-1.92); vulval papillae 0.103 x 0.044; egg 103 x 43 microns.

Description of Male *Oxyuris dubia*

Body elongate cylindrical, sharply curved at posterior end; esophagus with esophageal bulb; anterior portion of testes dorsal to esophagus, at approximate mid-point of organ, testes turns over esophagus and posterior portion runs ventral to esophagus; cuticle weakly annulated compared to the female; one distinct spicule.

Measurements:

The following measurements, based on one specimen, are in mm. Body length 1.08; width 0.059; length of esophagus

0.24; diameter of esophagus at entrance to esophageal bulb 0.015; Spicule length 0.044.

Development of *Oxyuris dubia*

Eggs were cultured in several media. (See methods and materials.) The most successful attempts were those carried out using filter paper and 0.7% saline solution, and faecal material kept in suspension with 0.7% saline solution.

Development was traced directly from the one-celled stage to a ten-celled stage. (See plate II). This pattern was reinforced with the observations made of eggs at different stages of development at the time of recovery. Attempts to carry growth beyond this stage failed. Two-, three-, four-, six-, nine-, and ten-celled stages were seen. Several eggs were recovered containing developed embryos.

TABLE I

NEMATODE PARASITES OF ANEIDES LUGUBRIS

Host No.	Date	No. *O. dubia*	Other Nematodes
1.	Nov. 1960	0	0
2.	May 1961	10	0
3.	May 1961	12	0
4.	May 1961	12	0
5.	May 1961	15	0
6.	May 1961	35	2
7.	May 1961	5	0
8.	May 1961	18	0
9.	May 1961	4	0
10.	May 1961	0	0
11.	May 1961	6	0
12.	May 1961	15	0
13.	May 1961	22	0
14.	Apr. 1962	4	0
15.	Apr. 1962	25	0
16.	Apr. 1962	45	0

Average Number of O. dubia per host-----------14.2

Average Number of helminthes per host---------14.5

Percent of Host Individuals infected----------87.5%

TABLE II

NEMATODE PARASITES OF *BATRACHOSEPS ATTENUATUS*

Host No.	Date	No. *O. dubia*
1.	Nov. 1960	0
2.	Nov. 1960	0
3.	Nov. 1960	0
4.	Nov. 1960	0
5.	Mar. 1962	0

TABLE III

NEMATODE PARASITES OF *ENSATINA ESCHSCHOLTZII*

Host No.	Immature/ Adult	Date	No. *O. dubia*
1.	Adult	Nov. 1960	2
2.	Adult	Nov. 1960	3
3.	Adult	Nov. 1960	8
4.	Adult	Nov. 1960	0
5.	Immature	Feb. 1962	0
6.	Immature	Apr. 1962	0

Average Number of *O. dubia* per host------------2

Average Number of *O. dubia* per adult host------3

Percent of hosts infected------------------------50%

Percent of adult hosts infected------------------75%

TABLE IV

NEMATODE AND TREMATODE PARASITES OF

TARICHA TOROSA SIERRAE

Host No.	Date	No. O. dubia	Capillaria sp.	Trematodes
1.	Mar. 1962	0	0	0
2.	Mar. 1962	3	3	0
3.	Mar. 1962	5	0	0
4.	Mar. 1962	3	0	0
5.	Mar. 1962	1	0	0
6.	Mar. 1962	15	0	3
7.	Apr. 1962	3	0	0

Average Number of *O. dubia* per host-------------------4.5

Average Number of Helminthes per host-----------------5.
Excluding *Capillaria* sp. larval forms.

Percent of Host Individuals Infected-----------------86%

TABLE V

NEMATODE AND CESTODE PARASITES OF

COASTAL ANEIDES LUGUBRIS

Host No.	Date	No. O. dubia	Cestodes
1.	Apr. 1962	0	0
2.	Apr. 1962	0	1
3.	Apr. 1962	14	0
4.	Apr. 1962	8	0
5.	Apr. 1962	8	0
6.	Apr. 1962	1	0
7.	Apr. 1962	0	0

Average Number of O. dubia per host----------------4

Average Number of Helminthes per host---------------4.5

Percent of Host Individuals Infected----------------71%

TABLE VI

NEMATODE AND TREMATODE PARASITES OF

COASTAL TARICHA TOROSA

Host No.	Date	No. O. dubia	No. Megalodiscus sp.
1 thru 6	Apr. 1962	0	0
7.	Apr. 1962	0	2
8.	Apr. 1962	0	1

Percent of host individuals parasitized--------------- 25%

DISCUSSION

Ecology of Salamanders:

It was determined after several collecting trips in the Sierra that salamanders were by no means abundant in this region. During the fall, winter and spring months, numerous collecting trips were made over the two year period to various communities in the Sierra. More than once, the collector returned empty handed from a day of hunting. When salamanders were found, the usual yield was limited to two or three specimens. This situation is in marked contrast to that of collecting in the coastal areas of California where salamanders are quite abundant Twitty (1959). The factors that account for the relatively small numbers of salamanders in the Sierra are, without a doubt, numerous. Several observations regarding their ecology have been made, and from them numerous assumptions can be drawn. It is well established that the environment in the Sierra is a harsh one compared to the coastal mountains and hillsides. Climatic, edaphic, and biotic factors in this area impose more restrictions on organisms attempting to live here. For example, seasonal variation in temperature in the lower Yellow Pine Forest range from -10°F to 95°F; (Ingles, L. G. Personal communication) the extremes of this temperature range are capable of imposing severe limitations on organisms. Edaphic factors combined with climatic factors might result in a lower biotic potential which could result in smaller numbers of producers, e.g., annual plants, and this in turn would have an ultimate effect on primary and secondary consumers. It may be assumed that these factors influence salamander populations.

Moisture is also a significant factor in influencing salamander populations. The dry warm summers of the Sierra, no doubt, serve as a limiting factor.

Weather conditions over the past few years, have probably had an effect. The past three years have been unusually dry years with annual precipitation levels at about 23 inches in the Yellow Pine Forest. The precipitation level during the winter and spring months of 1961-62 has approached a more normal condition for this region, which is about 38 inches. (U. S. Forest Service, Groveland Station records). Temperatures in the Sierra, however, have remained considerably below average during the spring of 1962. It may be assumed that salamander populations have probably been below average as a result of the long dry period. As rainfall has approached normal, cool temperatures have probably retarded the emergence of those salamanders in the region. Stebbins (1951).

From the limited data taken in this study, it could be said that salamanders are less well adapted to the Sierran environment than they are to the milder conditions of the coastal regions.

Parasites of Hosts

O. dubia was found to parasitize three of the four Sierra host species examined, the exception being *B. attenuatus*. It also parasitized *A. lugubris* of the coastal region. Two cestodes were found in the terrestrial *A. lugubris*. *Capillaria* sp., *Megalodiscus* sp., and unidentified trematodes were found in terrestrial-aquatic species *T. torosa* of the coastal region and *T. torosa sierrae* of the Sierra region. It is difficult to explain why *B. attenuatus* was not parasitized. The author has noted the presence of *O. dubia* in the same host species taken from the Santa Cruz mountains in a previous study. Lehmann (personal communication) has also reported the presence of *O. dubia* in coastal *B. attenuatus*. It seems unlikely that this host would not be exposed to the same parasites that are found in *A. lugubris* and *E. eschscholtzii* since they have overlapping ranges and their feeding habits are not markedly dissimilar Stebbins (1951). The most likely explanation that can be offered is that the sample taken in this study is too small to give any conclusive data concerning parasitism in this host.

It is obvious that even though parasites live in a rather ideal micro-environment, they are directly dependent on the host organism and its ability to survive in the external environment. From the data available, there is an indication that incidence of parasitism is greater in the host species taken from lower elevations where the environment is not as severe as in the higher elevations.

The information available from this study did not make it possible to make any significant correlations between incidence of infection and geographical distribution within a species. The same applies to correlating incidence of parasitism with seasonal variations.

O. dubia was observed in both terrestrial and terrestrial-aquatic salamanders. It would seem reasonable then that infection most likely occurred in the latter while the organism was on land. Infection by O. dubia most likely occurs when salamanders ingest eggs from faecal material of infected hosts. It is also possible that salamanders may eat organisms that have ingested the infective eggs Zweifel (1949).

Trematodes were observed only in the terrestrial-aquatic species. This is understandable on the basis that these organisms have a greater chance of ingesting encysted metacercariae on aquatic plant material, or may possibly ingest intermediate hosts.

The description offered for O. dubia is intended to clarify the original description by Leidy in 1856. His description was somewhat vague. It was assumed that the few measurements he took, using the line as a unit, refer to the older botanical use of the same unit which was 1/12 inch or about 2 mm. (Jepson 1957). The additional measurements given here should aid in further distinguishing the species O. dubia from the closely related *O. magnivulvaris* Rankin (1937).

The life cycle of *O. dubia* is not clearly understood. Very few males have been found in hosts studied to date. Rankin (1937) and Lehmann (1962, personal communication) have reported the finding of several males. It is possible that the males are essentially free living, and copulation occurs outside of the host as in *Strongyloides stercoralis* (Belding 1952). Development may also be completed in the host with filariform larvae, yielding an auto-infection. Neither of these assumptions has been verified. The fact that any males at all appear in the host raises several important questions. If eggs are ingested by the host at random, why is there not a nearly equal distribution of males and females? Is it possible that the males migrate very rapidly from the host to the outside environment? If this is so, does copulation occur inside of the host, and if so, when? Could these organisms be reproducing parthogenetically, or does the organism possess another type of mechanism which favors production of females over males, causing the very uneven male-female sex ratio? A very unequal sex ratio, however, does not necessarily indicate parthenogenesis (Belar 1923, 1924, cited by Sasser and Jenkins, 1960): one species of nematode, *Rhabditis monohystera*, is known to produce eggs that may follow one of two major pathways of development. Some eggs undergo only one maturation division, and penetration of the egg by a sperm, stimulates the egg to further development into a female (In this case the sperm degenerates, never having fused with the egg nucleus). Some eggs undergo two maturation divisions and are capable of fusing with the sperm pro-nucleus and develop into males. Whether or not a mechanism of this type is utilized by _O. dubia_ is not known, and further research will be necessary to resolve this problem.

The observation of the development of the eggs of _O. dubia_ establishes clearly that there is an unequal first cleavage producing a larger cell at the opercular end of the egg. This larger cell again divides unequally producing a three cell stage with a large central cell and two smaller terminal cells. The central cell then divides at right angles to the first two divisions. This produces the four-cell stage. The two central cells divide at right angles to the previous division producing the six-cell stage. The pattern of development of the nine- and ten-celled stages observed could not be accurately determined. It was noted in an original and verified in a repeat experiment that the two-cell stage was developed after 24 hours, the three-cell stage after 48 hours, and the four-cell stage, after 96 hours. It was thought that in the original experiment that the eight- or nine-cell stage was reached after six days, but this could not be verified in the repeat experiment.

The failure of eggs to proceed in development beyond the ten-cell stage is probably due to one of the two following reasons. Either the correct medium has not been selected for growth needs, or the metabolism of the developing egg requires anaerobic conditions. It is suspected that the latter may be the case.

SUMMARY

Four species of salamander hosts of the central region of the California Sierra Nevada Mountain Range were examined for nematode parasites. They were *Aneides lugubris*, *Batrachoseps attenuatus attenuatus*, *Ensatina eschscholtzii platensis* and *Taricha torosa sierrae*. A second group of salamanders was examined, which included the species *Aneides lugubris* and *Taricha torosa*; these organisms were natives of the Marin County coastal region and they served the function of a comparison group.

Oxyuris dubia was found to be the principle helminth parasite in all Sierra species except in *Batrachoseps attenuatus*. *Capillaria* sp. was observed in *T. torosa sierrae* and an unidentified nematode was observed in *A. lugubris* of the Sierra region. Several unidentified cestodes and trematodes were observed in Sierran hosts. *O. dubia* as well as one unidentified species of cestode were found in the Coastal *A. lugubris*. Examination of the coastal *T. torosa* revealed the presence of the trematode *Megalodiscus* sp.

Additional descriptive information has been given for *O. dubia* to expand Leidy's original description of 1856.

Eggs of *O. dubia* were cultured *in vitro* to the ten-cell stage. It is thought that anaerobic conditions are necessary to continue development beyond this point.

LITERATURE CITED

Belding, David L. 1952. Textbook of Clinical Parasitology. Appleton-Century-Crafts Inc., New York, N. Y.

Cable, Raymond M. 1957. An Illustrated Laboratory Manual of Parasitology. Burgess Publishing Co., Minneapolis 15, Minn.

Chandler, Asa C. 1955. Introduction to Parasitology. John Wiley & Sons Inc., New York, N. Y. 449-453.

Guyer, Michael F. 1947. Animal Micrology. The University of Chicago Press, Chicago, Ill.

Hegner, Robert & F. M. Root & D. L. Augustine 1929. Animal Parasitology. D. Appleton-Century Company Inc., New York, N. Y.

Ingles, Lloyd Glenn 1954. Mammals of California Stanford University Press, Stanford, California

Jepson, Willis Linn 1957. A Manual of the Flowering Plants of California. University of California Press, Berkeley, California.

Lehmann, Donald L. 1954. Some helminths of west coast Urodeles. The Journal of Parasitology 40 (2).

__________ 1956. Some helminths of Oregon Urodeles. The Journal of Parasitology, 42 (1): 25.

__________ 1960. Some parasites of central California amphibians. The Journal of Parasitology, 46 (1): 10.

Leidy, J. 1856. A synopsis of entazoa and some of their ectocongeners observed by the author. Acad. Nat. Sci. Phila, Proc. 8:42-58.

Munz, Philip A. & David D. Keck 1959. A California Flora. University of California Press, Berkeley, California.

Odum, Eugene P. 1959. Fundamentals of Ecology. W. B. Saunders Company, Philadelphia, Pa. 245-287.

Oosting, Henry J. 1956. The Study of Plant Communities. W. H. Freeman and Company, San Francisco, California

Rankin, J. S., Jr. 1937. An ecological study of parasites of some North Carolina salamanders. Ecol. Monogr. 7:169-270.

Sasser, J. N. & W. R. Jenkins 1960. Nematology. The University of North Carolina Press, Chapel Hill, North Carolina.

Stebbins, Robert C. 1951. Amphibians of Western North America. University of California Press, Berkeley, California

Twitty, V. C. 1955. Field experiments on the biology and genetic relationship of the California species of *Triturus*. The Journal of Experimental Zoology 129 (1): 129-148.

__________ 1959. Migration and speciation in newts. Science 130 (3391): 1735-1743.

Walton, A. C. 1935. The Nematoda as parasites of Amphibia. The Journal of Parasitology 21(1): 27-50.

Zweifel, R. G. 1949. Comparison of food habits of *Ensatina eschscholtzii* and *Aneides lugubris*. Copeia 4:285-287.

EXPLANATION OF PLATES

Plate I.

A. Male *Oxyuris dubia* lateral view x 100

B. Female *Oxyuris dubia* lateral view x 60

Plate II.

Eggs of *Oxyuris dubia* (x500) in various stages of development.

Fig. 1 One-cell stage

Fig. 2 Two-cell stage

Fig. 3 Three-cell stage

Fig. 4 Four-cell stage

Fig. 5 Five-cell stage

Fig. 6 Six-cell stage

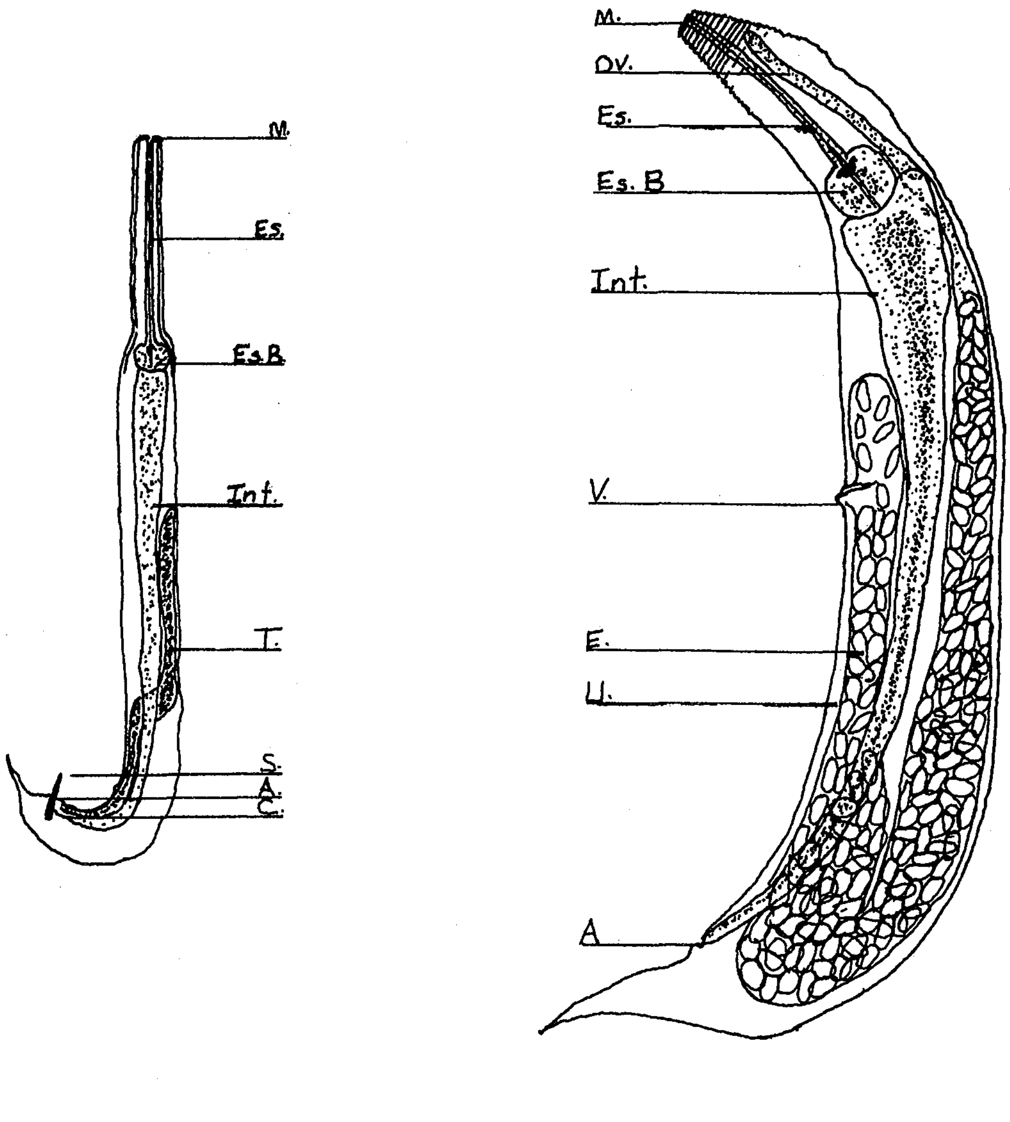
Fig. 7 Nine-cell stage

Fig. 8 Ten-cell stage

ABBREVIATIONS

A.	anus
C.	cloaca
E.	eggs
Es.	esophagus
Es. B.	esophageal bulb
Int.	intestine
M.	mouth
Ov.	ovary
S.	spicule
T.	testis
U.	uterus
V.	vulva

PLATE I



A.　　　　B.

PLATE II

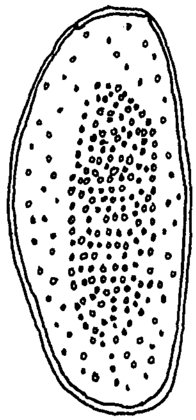


Fig. 1.

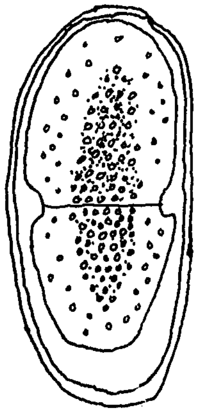


Fig. 2

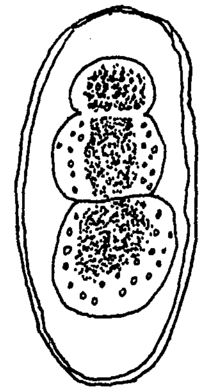


Fig. 3

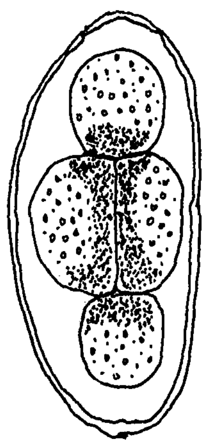


Fig. 4

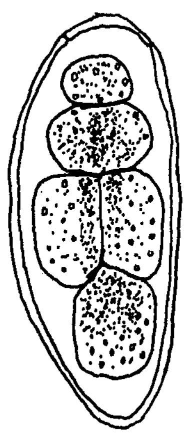


Fig. 5

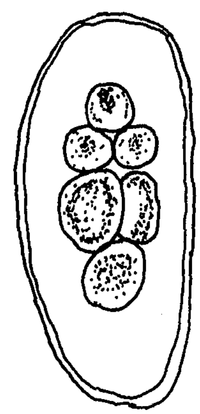


Fig. 6

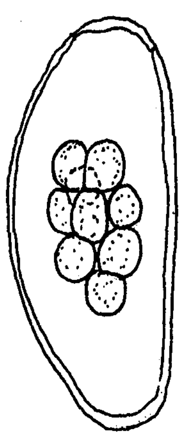


Fig. 7.

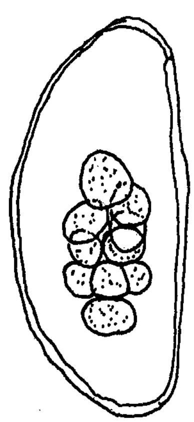


Fig. 8.

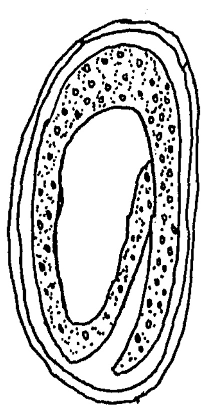


Fig 9.